BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

EP1063840 Biblio | Desc | Claims | Page 1 | Drawing

esp@cenet

Enchanced color correction

Patent Number: EP1063840

Publication date: 2000-12-27

Inventor(s): PETTITT GREGORY S (US)

Applicant(s): TEXAS INSTRUMENTS INC (US)

Requested Patent: TW476217

Application Number: EP20000201568 20000502

Priority Number(s): US19990131733P 19990430

IPC Classification: H04N1/60; H04N9/68

EC Classification: H04N1/60D, H04N9/68

Equivalents: JP2000358252

Cited Documents:

Abstract

A method and apparatus for correcting the color of an image signal. Data in a first color space such as RGB is converted (502) to primary/secondary/combined color space by setting combined color word equal to the minimum of the input values, the primary color word equal to the maximum of the input values minus the combined color word, and the secondary color word equal to the median of the input values minus the combined color word. A set of three coefficients is selected (506) for each of the primary color word, the secondary color word, and the combined color word. The primary, secondary, and combined color words are then multiplied by the coefficients by a matrix multiplier (504) to yield color-corrected data in the first color space.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 063 840 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
27.12.2000 Bulletin 2000/52

(51) Int. Cl.[7]: **H04N 1/60**, H04N 9/68

(21) Application number: **00201568.3**

(22) Date of filing: **02.05.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **30.04.1999 US 131733 P**

(71) Applicant:
Texas Instruments Incorporated
Dallas, Texas 75251 (US)

(72) Inventor: **Pettitt, Gregory S.**
Rowlett, Texas 75088 (US)

(74) Representative: **Holt, Michael**
Texas Instruments Limited,
European Patents Department (MS 13),
PO Box 5069
Northampton NN4 7ZE (GB)

(54) Enchanced color correction

(57) A method and apparatus for correcting the color of an image signal. Data in a first color space such as RGB is converted (502) to primary/secondary/combined color space by setting combined color word equal to the minimum of the input values, the primary color word equal to the maximum of the input values minus the combined color word, and the secondary color word equal to the median of the input values minus the combined color word. A set of three coefficients is selected (506) for each of the primary color word, the secondary color word, and the combined color word. The primary, secondary, and combined color words are then multiplied by the coefficients by a matrix multiplier (504) to yield color-corrected data in the first color space.

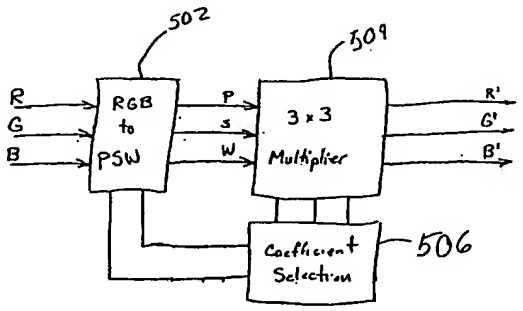

FIG. 5

EP 1 063 840 A2

Description

FIELD OF THE INVENTION

[0001] This invention relates generally to the field of display systems, and more particularly to color correction of display systems, particularly display systems using primary color sources to generate full color images.

BACKGROUND OF THE INVENTION

[0002] Image display systems create images for a human viewer to experience. The goal of the display systems is to simulate the experience of being at the location being displayed. These locations may be real, for example when a scene is recorded using a camera, imaginary, for example when a computer generates a scene using a database of shape and texture information, or a combination of real images and superimposed computer generated images.

[0003] Regardless of the source of a particular image, the display system must be able to recreate the complex color tones and intensities in order to make the recorded image appear life-like. To do this, the color spectrum of the display system must be correlated to the color spectrum of the device used to capture the image. This can be a particular challenge when displaying an image initially recorded on a continuous color media such as cinemagraphic film on a primary color-based system such as a CRT, LCD, or DMD display. For the purposes of this disclosure, the term "continuous color" used in conjunction with terms such as image, media, display, or system will refer to the characteristic of being comprised of a continuous spectrum of light compared to the term "primary color" which refers to the characteristic of being comprised of light from discrete primary color bands.

[0004] The perceived color of an object is determined by the wavelength of the light emitted by or reflected by the object. The human eye contains sensors, called rods and cones, that detect the light from the object focused on the retina. Rods are responsible for low light vision. Cones are responsible for the color vision. There are three types of cones in the human eye, each with a distinct pass band. Using the output from the three types of cones, the human brain creates the perception of color and intensity for each portion of an image.

[0005] Continuous color media recreate the original image spectrum for each portion of the image. In the case of photographic film, this is accomplished by absorbing the unwanted portions of the spectrum of light from a source while reflecting or transmitting the portions needed to create an image. Primary color systems cannot recreate the entire spectrum of the original image, but instead create the perception of the original image by stimulating the three types of cones to produce a response which is the same as provided by the original spectrum. Thus, three carefully chosen light sources (red, green, and blue) can be used to provide the perception of a continuous color spectrum.

[0006] The three colors chosen to be the primary colors of a primary color display system determine the available color space of the display system. While a given set of primary colors may provide a very broad color space, the use of filters to select the given set of primary colors from a white light beam often limits the maximum intensity the display system is capable of producing to less than a minimum acceptable amount. Likewise, a given selection of color filters may result in a white level, formed by combining the three primary colors, that has a undesirable color tint.

[0007] While an ideal display can create a high intensity display of very pure colors including white, real world display systems must make tradeoffs between the white level, purity of the primary colors, and the maximum available brightness. These tradeoffs affect the secondary colors since the secondary colors are formed by combining primary colors using an intensity word indicative of the intensity of each primary relative to the maximum intensity of that primary color. Thus, once the primary color filters are selected, the white point and the purity of the secondary colors is also determined.

[0008] U.S. patent Application No. 09/175,810 entitled "Brightness gain using white segment with hue and gain correction" filed 20th October 1998 and having the same Assignee as the present application, discloses a display system (902) and method for increasing the brightness of an image through the use of a color wheel (504) having a white light generating segment. The display system comprises a RGBW processing function (906) that includes circuitry to generate an intensity word for use during the white light generating segment. The hue correction function (906) includes circuity to adjust the relative intensities of the primary color components to compensate for the addition of the white segment data. The gain correction function (904) includes circuitry to adjust the intensity of the pixel data based upon the white content of the pixel and the intensity of the pixel. After the pixel data is processed, it is formatted by data formatting logic (912) and displayed using a spatial light modulator (914).

SUMMARY OF THE INVENTION

[0009] Objects and advantages will be obvious, and will in part appear hereinafter and will be disclosed by the present application which teaches a method and system for the enhanced color correction of image data. One disclosed embodiment of the present invention provides a method of correcting color image data for a pixel. The method

comprising the steps of: providing intensity data for three primary colors, a plurality of secondary colors, and a combined color for the pixel; providing a set of matrix coefficients for each output primary color, one said coefficient for describing the contribution said output primary color makes to each of the primary, secondary, and combined colors; and summing the products of the matrix coefficients and corresponding intensity data to provide a corrected intensity data value for each output primary.

[0010] According to a second embodiment of the present invention, a method of correcting color image data for a pixel is disclosed. The method comprising the steps of: providing image data for the pixel, converting the image data to a color space having a primary, secondary, and combined color component; providing coefficients describing the contribution made each of three output primary colors to the formation of said primary, secondary, and combined color components; and summing the products of said coefficients and said primary, secondary, and combined color components to provide a corrected intensity data value for each output primary.

[0011] According to yet another embodiment of the disclosed invention, a method of correcting color image data for a pixel is disclosed. The method comprising the steps of: providing image data for said pixel; converting said image data to a color space having a primary (P), secondary (S), and combined (C) color component; selecting a set of coefficients describing the contribution of the primary, secondary, and combined components to the output primaries, and calculating a corrected output value for each said output primary according to the following equation:

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} X_{RP} & X_{RS} & X_{RW} \\ Y_{GP} & Y_{GS} & Y_{GW} \\ Z_{BP} & Z_{BS} & Z_{BW} \end{bmatrix} \begin{bmatrix} P \\ S \\ C \end{bmatrix}$$

where:

X_{RP} is the contribution of the primary color component to a first output primary (R')
X_{RS} is the contribution of the secondary color component to the first output primary (R')
X_{RC}) is the contribution of the combined color component to the first output primary (R')
Y_{GP} is the contribution of the primary color component to a second output primary (G')
Y_{GS} is the contribution of the secondary color component to the second output primary (G')
Y_{GC} is the contribution of the combined color component to the second output primary (G')
Z_{BP} is the contribution of the primary color component to a third output primary (B')
Z_{BS} is the contribution of the secondary color component to the third output primary (B')
Z_{BC} is the contribution of the combined color component to the third output primary (B')

[0012] The disclosed methods and systems provide independent control over the primary and secondary image colors, as well as over the combined color component-typically the white level. As implemented, the described methods and systems require very little additional processing power and therefore can be implemented in real time without excessive cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a CIE 1931 xy chromaticity diagram of the color space of a first display system.
FIGURE 2 is a CIE 1931 xy chromaticity diagram of the color space of a second display system showing shifted secondary color points.
FIGURE 3 is a CIE 1931 xy chromaticity diagram of the color space of a third display system showing the independent adjustment of the secondary color points.
FIGURE 4 is a graph of three hypothetical primary color intensity data values for a single pixel showing the allocation of the RGB data into PSW space.
FIGURE 5 is a block diagram depicting one embodiment of an apparatus for improving color correction.
FIGURE 6 is a circuit diagram showing one implementation of the improved color correction.
FIGURE 7 is a block diagram of a film to video transfer system utilizing the improved color correction of the present invention to translate digitized image data prior to storing and later retrieving and displaying the translated image data.

Enchanced color correction

Patent Number: EP1063840
Publication date: 2000-12-27
Inventor(s): PETTITT GREGORY S (US)
Applicant(s): TEXAS INSTRUMENTS INC (US)
Requested Patent: ☐ EP1063840
Application Number: EP20000201568 20000502
Priority Number(s): US19990131733P 19990430
IPC Classification: H04N1/60; H04N9/68
EC Classification: H04N1/60D, H04N9/68
Equivalents: ☐ JP2000358252, TW476217
Cited Documents:

Abstract

A method and apparatus for correcting the color of an image signal. Data in a first color space such as RGB is converted (502) to primary/secondary/combined color space by setting combined color word equal to the minimum of the input values, the primary color word equal to the maximum of the input values minus the combined color word, and the secondary color word equal to the median of the input values minus the combined color word. A set of three coefficients is selected (506) for each of the primary color word, the secondary color word, and the combined color word. The primary, secondary, and combined color words are then multiplied by the coefficients by a matrix multiplier (504) to yield color-corrected data in the first color space. 

HOME

DECEMBER 2002

STUDIO ONE IS PLEASED TO ANNOUNCE THAT WE HAVE NOW INSTALLED A

NIKON SUPER COOLSCAN 8000 ED SCANNER

Complete details at www.nikon.ca

This gives Studio One the capability of providing SUPER HIGH RESOLUTION approaching drum quality scan quality for slides and negatives from 35mm to 6 x 7 cm.
This amazing scanner incorporates Enhancement Software Programs
DIGITAL ICE, DIGITAL ROC and DIGITAL GEM
which are trademarks of Applied Science Fiction Inc. Their website is www.asf.com

- **ICE** will clean up dust and particles. This is extremely important, especially for 35mm slides.

These slides sit around for years, sometimes in trays and they get covered with tiny particles of dirt. Often a favourite slide will get handled a lot and so will acquire all kinds of dirt. Often this dirt cannot be cleaned off.
The dirt and imbedded particles will make it impossible to obtain a satisfactory enlargement.
The cost of standard photo manipulation to get rid of the dirt would be prohibitive.
The **ICE** program now solves 99.8% of this problem instantly.

- **ROC** is used to enhance and restore colour.

Colours fade over time as a result of storage conditions, sunlight, humidity and temperature to name just a few.
Fading may not even be uniform, but can affect only the highlights for instance, and may even result in blotchy colour fading.
ROC automatically and meticulously rebuilds the lost colour values by identifying clues in the original.

This results instantly in complete restoration of the original colour.

- **GEM** is used to reduce the effect of graininess.

Excessive grain makes a picture look coarse, and breaks the picture up and breaks up sharpness.
This program analyses the negative or slide pixel by pixel.
The resulting image is sharper and more detailed without the grainy look.